



The Solutions Network

Rochester, New York

Performance Metrics

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Overview

- ❖ Whats and Whys of Performance Metrics
- ❖ How to Select Performance Metrics
- ❖ Sources of Building Performance Metrics
- ❖ Interactive Session

August 8-11, 2004

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Performance Metrics?

- ❖ A **Performance Metric** is a standard of measurement of a function or operation
 - a.k.a. **Performance Indicator**
 - Usually reserved for high level metrics





How Performance Metrics are Used

- ❖ Measure progress toward a goal
 - Reduce Energy consumption by 40%
- ❖ Standardized comparisons
 - Benchmark performance
 - Track long-term performance
 - Compare with other buildings
- ❖ Used from the design to the end of life



Need for Standard Metrics

- ❖ "Weights and measures may be ranked among the necessities of life ..."
John Quincy Adams, 1821
- ❖ Standard units of measure provide a common language for commerce, science, laws, and other aspects of everyday life.



History of English Length Measurement

- ❖ At one time measurement of length was not standardized – much like sustainability metrics today.
- ❖ Inch was based on the thumb then later standardized as three barleycorns
- ❖ Foot was based on the human foot then standardized as 13 inches, and finally King Henry I (1100-1135) established the foot as 12 inches
- ❖ The inch and foot are now defined from the yard, which is 0.9144 meters



Why are Standardized Performance Metrics Important?

- ❖ Common language and benchmarks
- ❖ Consistent treatment of measurements
→ Repeatable & Comparable
- ❖ Greater confidence in results
 - Better confidence leads to better market acceptance
- ❖ Better understanding of real performance



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Issues with Building Performance Metrics

❖ Energy Use Intensity = Energy/Area

➤ Energy

- What is and what is not included?
- How is it measured?
- How are energy types combined? (elec., gas, steam, on-site production, etc.)

➤ Area

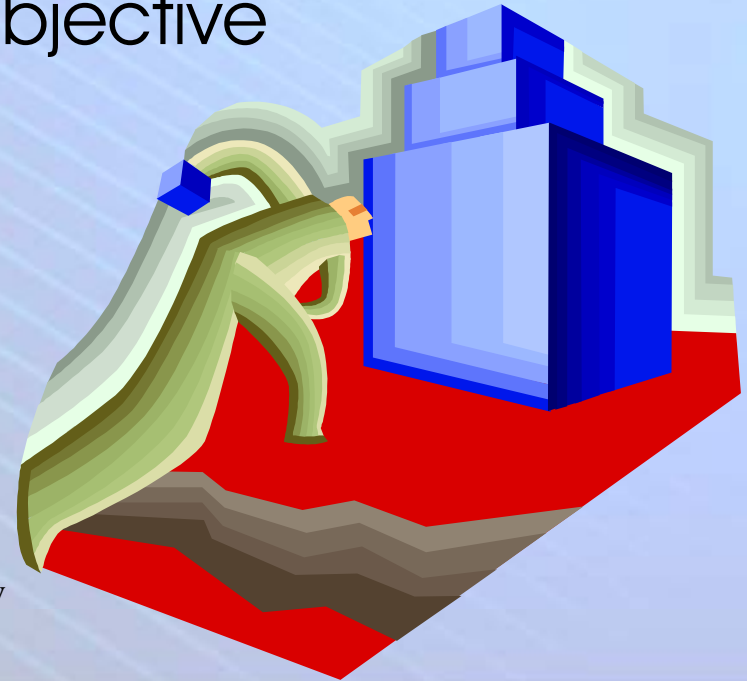
- Include walls?
- Parking garages?
- Unconditioned spaces?





Attributes of Good Performance Metrics

- ❖ Clear definition
- ❖ Measurable
- ❖ Standardized
- ❖ Shows a clear relationship to the desired goal or objective
 - Measures and communicates progress toward the goal



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Selecting Building Performance Metrics – I

- ❖ What do we mean by “Building Performance”?
 - Broad term and difficult to measure
- ❖ Divide the “Performance” in to topic areas and subtopic areas until you get to something that is measurable.
- ❖ Your values and society values help determine the topic and subtopic areas



Selecting Building Performance Metrics – II

❖ Example Building Performance Topic Areas (high level metrics)

- Environmental
- Social
- Economic
- Service Quality



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Selecting Building Performance Metrics – III

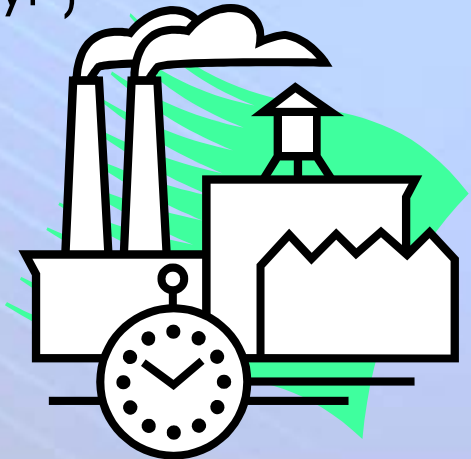
- ❖ Examples of Subtopic Areas – Environmental (mid level metrics)
 - Energy consumption for operations
 - Water
 - Material
- ❖ Difficult to aggregate performance across topic and subtopic areas
 - Cost is sometimes used





Selecting Building Performance Metrics – IV

- ❖ Start with a clearly defined goal
 - Reduce annual CO₂ production from building operations by 20% compared to CO₂ production in 1990
- ❖ Possible metric
 - Facility annual GHG emissions intensity, CO₂ equivalent (kg CO₂/ft²/yr)





Selecting Building Performance Metrics – V

❖ Define Data Required

- Building area
- Primary energy consumption by fuel type
- GHG emissions for energy conversion processes
- Other sources of GHG emissions
 - Refrigeration system leakage
 - Industrial processes





Selecting Building Performance Metrics – VI

- ❖ Define data sources
 - Reliability
 - Uncertainty
 - Cost
- ❖ Define data archiving methods
- ❖ Assign a responsible party



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Sources of Building Performance Metrics

- ❖ DOE/NREL Performance Metrics Project
- ❖ DOE High Performance Buildings Database
- ❖ USGBC – LEED
- ❖ CBECS (Commercial Building Energy Consumption Survey)
- ❖ EPA EnergyStar
- ❖ ASHRAE Standard 105 (under revision)
- ❖ International Green Building Challenge (GBC)



DOE/NREL Performance Metrics Project (PMP)



NREL PIX #12627

Multiyear effort to standardize the measurement & characterization of building **energy** performance

- Clearly defined Performance Metrics
- Standard methods for collecting, analyzing, and reporting data

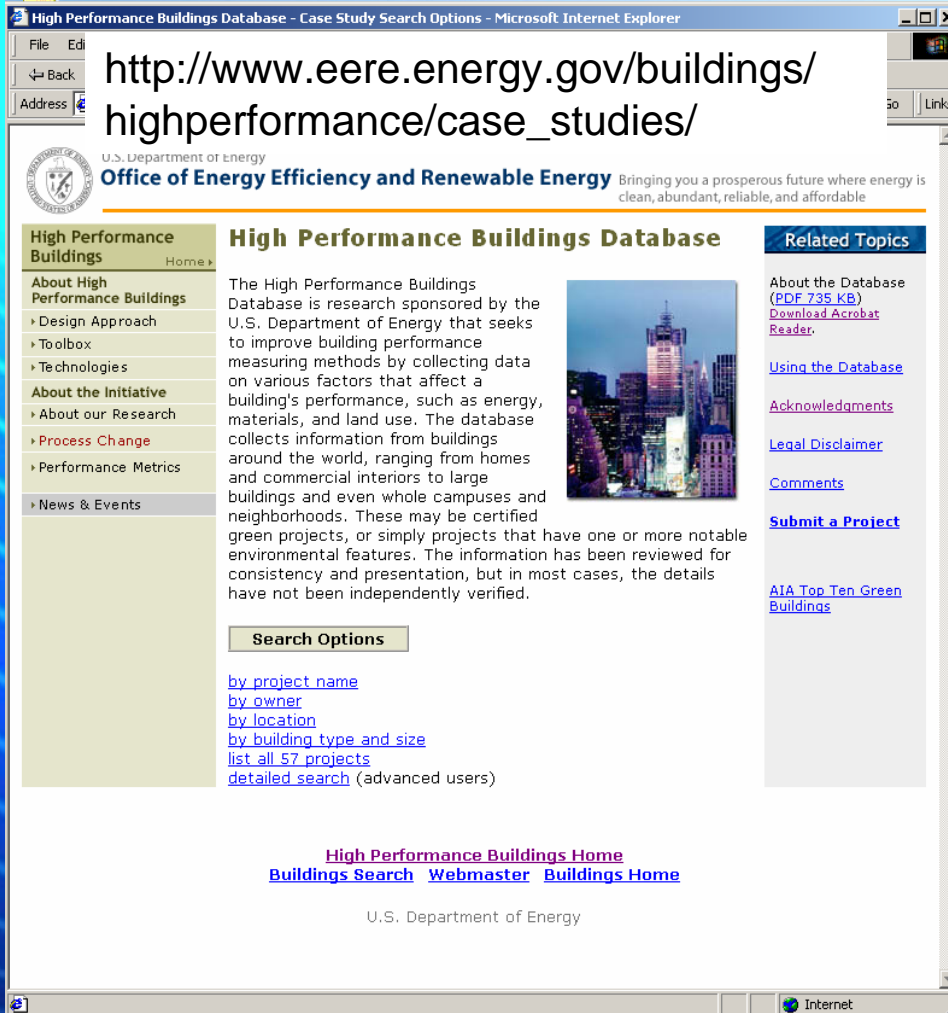
<http://www.highperformancebuildings.gov>
Click on "performance metrics"

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DOE High-Performance Building Database



- ❖ Showcase for sustainable buildings
- ❖ Contains measured performance data
- ❖ Projects can be entered by anyone
- ❖ Accessible to everyone
- ❖ Can be used to motivate future builders on what is possible.

<http://highperformancebuildings.gov>
v

Click on "Enter the database"

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Green Building Challenge

2002 Performance Metrics

Selected Environmental Sustainability Indicators for the Design		per m ² only	by area & by occupancy	
ESI-1	Total net consumption of primary embodied energy, GJ	1.7	8.6	(MJ/m ²) / (kaph/m ²)
ESI-2	Net annualized consumption of primary embodied energy, MJ	23	114	(MJ/m ²) / (kaph/m ²)
ESI-3	Net annual consumption of primary energy for building operations, MJ	357	1815	(MJ/m ²) / (kaph/m ²)
ESI-4	Net annual consumption of primary non-renewable energy for building operations, MJ	316	1607	(MJ/m ²) / (kaph/m ²)
ESI-5	Net annualized primary embodied energy and annual operating primary energy, MJ	339	1721	(MJ/m ²) / (kaph/m ²)
ESI-6	Net area of land consumed for building and related works, m ²	0.3	4.9	m ² / occupant
ESI-7	Net annual consumption of potable water for building operations, m ³	14	49	m ³ / (aph/m ²) * yr
ESI-8	Annual use of grey water and rainwater for building operations, m ³	2	9	m ³ / (aph/m ²) * yr
ESI-9	Net annual GHG emissions from building operations, kg. CO ₂ equivalent	38	195	(Kg. eCO ₂ / m ²) / (kaph / m ²)
ESI-10	Predicted CFC-11 equivalent leakage per year in gm.	0.000417	0.002121	(gm CFC-11 equiv / m ²) / (kaph * m ²) * yr
ESI-11	Total weight of materials re-used in Design from on-site or off-site uses, kg.	933	4741	kg / (aph/m ²) * yr
ESI-12	Total weight of new materials used in Design from off-site uses, kg.	430	2186	kg / (aph/m ²) * yr

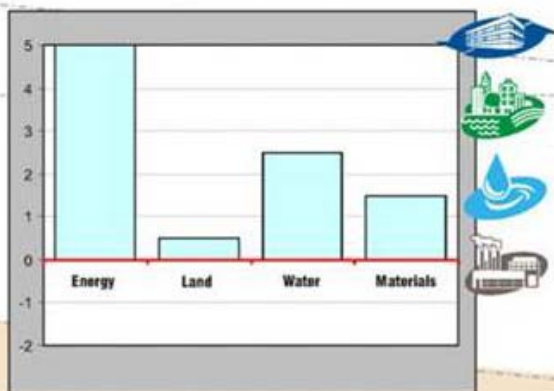
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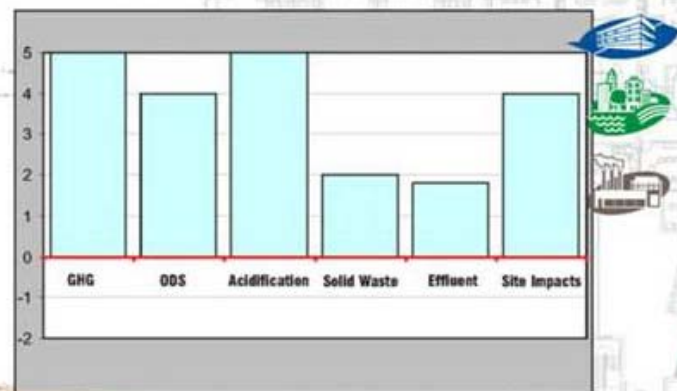
GBC Assessment Tool – GBTool

Resource Consumption



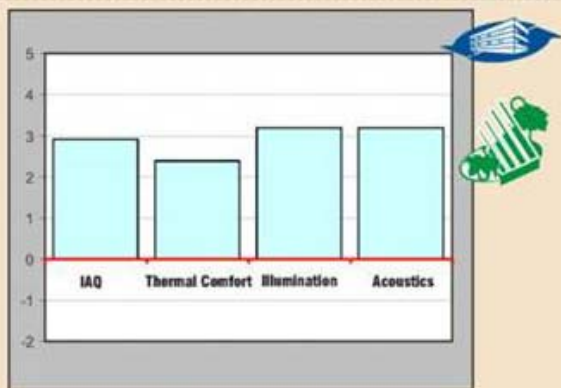
Relatively low scores for Land and Materials reflect 1) site selection, and 2) the building being a new construction project.

Environmental Loadings



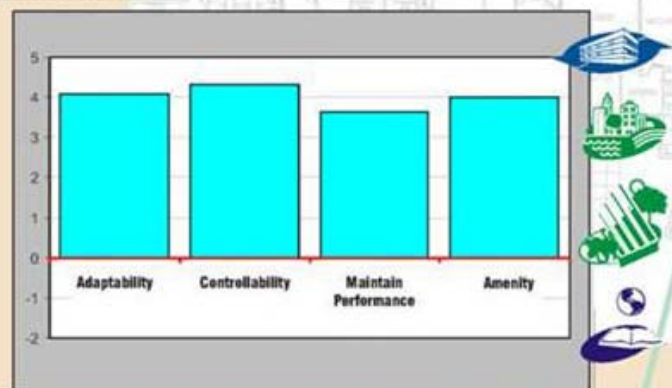
Scoring indicators increase attention to solid waste and effluent issues required on future projects.

Indoor Environmental Quality



Deficiencies in this area all related to standard practices in the USA and will be used to inform future projects.

Quality of Service



Good scoring in this area due to use of a raised access flooring system, installation of energy and IAQ monitoring systems, and parking lot design.

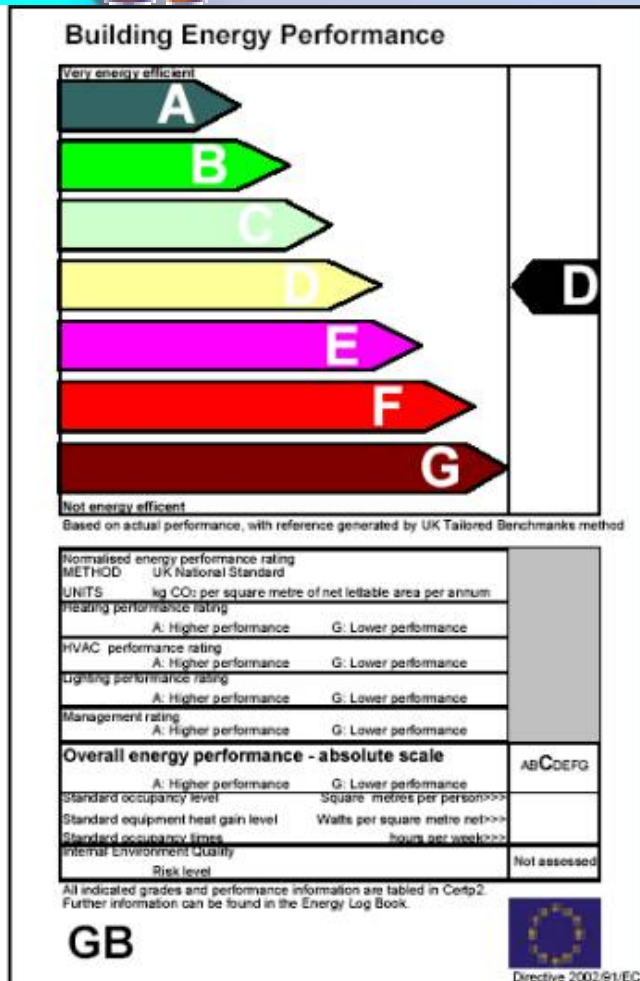
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International Efforts in Building Performance – I

Energy Certificate



❖ European Union

- EU plans to require certification of energy performance starting in 2005
- Metrics: kg CO₂/m²
 - Rates performance on greenhouse gas potential



International Efforts in Building Performance – II

- ❖ BREEAM – UK (First system - 1990)
<http://products.bre.co.uk.breeam>
- ❖ Green Star/ABGR – Australia
<http://www.gbcaus.org.greenstar>
- ❖ CRISP – Database of European efforts
<http://crisp.cstb.fr>
- ❖ ISO – new standards for sustainability of buildings being developed



Performance Metrics Definition Example

- ❖ Select a subtopic area
- ❖ Set performance goals
- ❖ Define ideal performance metrics
- ❖ Define data requirements
- ❖ Define data sources